

Mermentau River Basin--Water Quality

Dissolved Oxygen and Biochemical Oxygen Demand

During September 15-27, 1989, DO concentrations, measured hourly at sites 1, 6, 7, and 8 (probe failure occurred at sites 12 and 13), indicate a significant 24-hour variation (fig. 4). This variation is more typical of lakes than of rivers, and indicates that, in some ways, the tributaries function as long, narrow lakes. During September 19-21, 1989, day-time DO concentrations exceeded saturation concentrations at sites 7 and 8. At the same time, there were pronounced increases in pH at these sites. This pattern of DO and pH variation is characteristic of photosynthetic activity. As algae photosynthesize, they remove dissolved CO₂ (carbon dioxide), which forms a weak acid, from the water, increasing the pH. The low DO concentrations at site 1 (less than 2.0 mg/L) were consistently less than the 4.0 mg/L minimum considered necessary to support estuarine fish populations (Louisiana Department of Environmental Quality, 1990b). The 24-hour DO variations shown in figure 4 are probably at or near the maximum daily range in extremes of DO concentrations that typically occur during a year. In the fall and winter, lower water temperatures generally limit algal growth and lessen 24-hour DO variations.

Five-day BOD values at the 13 sites sampled ranged from 0.7 to 6.0 mg/L (fig. 5) and generally are comparable to values reported for other streams in southern Louisiana. However a BOD of 6.0 mg/L at site 2 indicates that water at this site contains a larger amount of organic matter than does water at the other sites.

Specific Conductance and Inorganic Constituents

The specific conductance and concentrations of major inorganic constituents at 10 of the 13 sites sampled (table 3) were typical of freshwater streams in southern Louisiana. Specific conductance, which is indicative of the total amount of dissolved ions capable of conducting an electrical current, was less than 400 µS/cm at all sites except sites 2 and 13. Samples collected at sites 2 and 13 had specific conductances of 551 and 7,150 µS/cm. The specific conductance and dissolved chloride concentration at site 13 indicates the effect of saltwater in the tidal reach of the river on water quality. A specific conductance of 551 µS/cm at site 2 (table 3) probably indicates a nearby inflow of water with a relatively high dissolved-solids concentration, because the conductance decreases to 181 µS/cm downstream at site 6 on Bayou Plaquemine. The decrease in conductance between sites 2 and 6 probably is not due solely to dilution, because there are no significant inflows between these two sites. A likely explanation for the decrease in specific conductance is that intermittent operation of irrigation pumps causes localized and transient flow changes, moving water upstream or downstream. The tributaries of the Mermentau River are heavily utilized as a source of irrigation water; average annual withdrawals for irrigation are estimated at 129.46 Mgal/d (fig. 6) (John K. Lovelace, U.S. Geological Survey, written commun., 1991). This intermittent pumping, in combination with tidal movement, could also explain the difference in discharge between sites 2 and 6 (5.0 and 46.7 ft³/s, fig. 3). Apparently a mass of water in temporary storage above site 6 began to move downstream in response to a stage change, although it is unclear whether the change was caused by tides, pumping, or a combination of the two. The combination of local inflows, pumping, and slow streamflow velocities probably accounts for substantial differences in inorganic constituents over short reaches.

Specific conductance data from the monitors at sites 1, 6, 7, 8, 12, and 13 (fig. 4) indicate that brackish water from the Gulf of Mexico was detected only at site 13, which is located just a few miles from the gulf. Therefore, saltwater had a limited influence on water quality at the other sites sampled during the study. Data collected at site 13 indicate semi-diurnal or diurnal variations in specific conductance of less than 1,000 to about 40,000 µS/cm during the September 19-21, 1989, sampling period (fig. 4).

Table 3. Specific conductance and concentrations of selected inorganic constituents in water, September, 19-21, 1989
[Specific conductance in microsiemens per centimeter at 25 degrees Celsius; concentrations in milligrams per liter]

Property or constituent	Value or concentration at indicated site												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Specific conductance	260	551	292	387	193	181	260	156	178	148	94	125	7,150
Calcium, dissolved	17	37	18	21	9.3	12	15	11	12	11	1.2	7.4	43
Magnesium, dissolved	5.4	12	5.5	6.5	3.5	3.6	5.4	3.4	3.7	3.6	2.7	2.7	180
Sodium, dissolved	24	48	27	41	22	15	27	13	15	12	11	10	1,900
Potassium, dissolved	5.4	8.8	4.3	5.0	3.7	5.6	5.5	4.2	5.0	4.0	2.7	3.5	50
Alkalinity, total, as calcium carbonate	64	126	81	79	61	50	62	46	51	45	15	33	37
Sulfate, dissolved	4.0	7.6	3.2	16	2.5	2.5	4.0	3.0	3.4	3.6	4.0	1.7	310
Chloride, dissolved	32	52	28	47	19	17	41	16	18	14	14	14	3,250
Fluoride, dissolved	.2	.3	.2	.3	.3	.1	.2	.2	.2	.2	.2	.2	.4

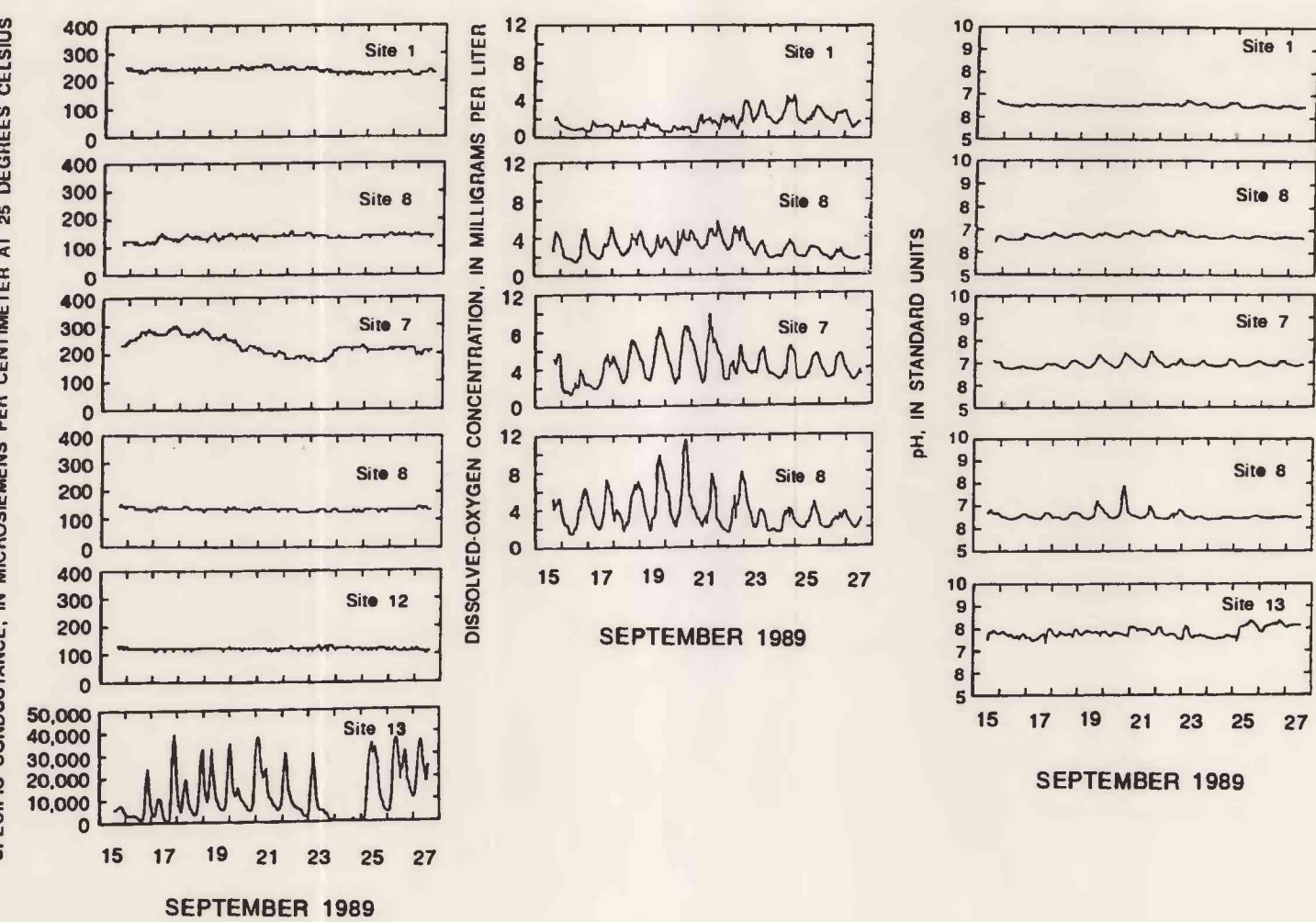


Figure 4. Hourly specific conductances, dissolved-oxygen concentrations, and pH values at a depth of 3 feet at monitoring sites, September 15-27, 1989.

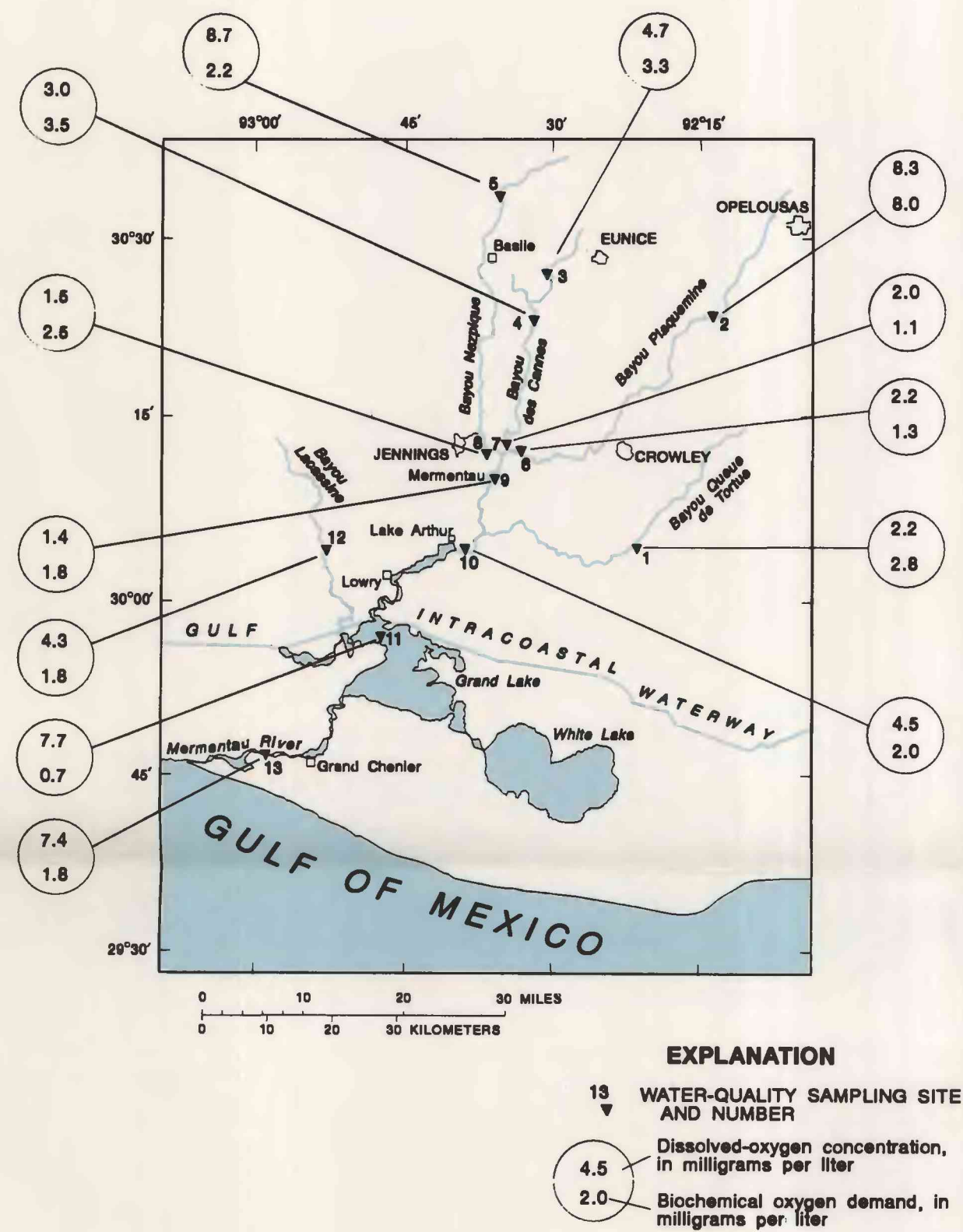


Figure 5. Distribution of dissolved-oxygen concentrations and biochemical oxygen demand, at a depth of 3 feet at monitoring sites, September 19-21, 1989.

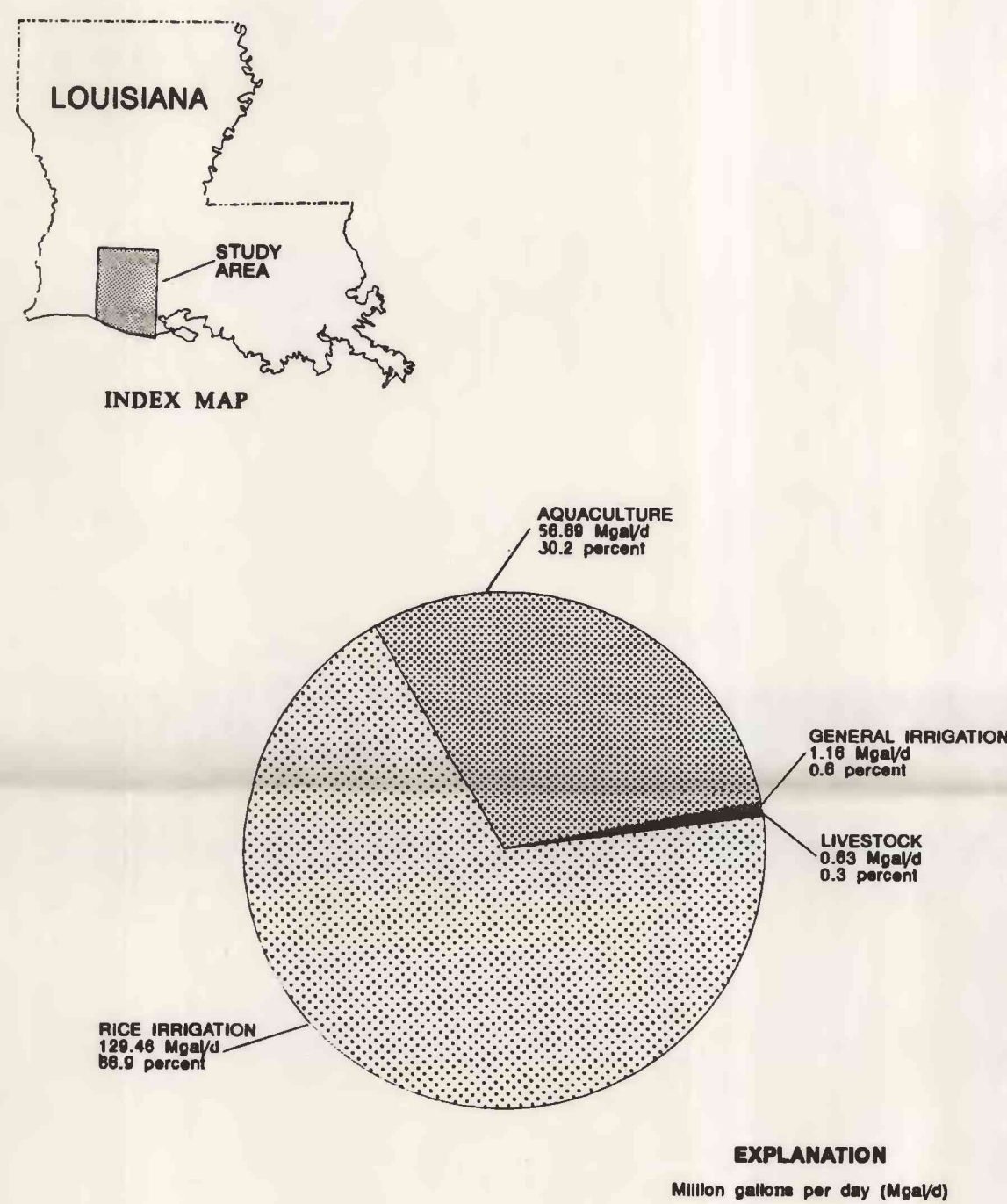


Figure 6. Surface-water withdrawals in the Mermentau River basin, 1989-90.

LOUISIANA HYDROLOGIC ATLAS MAP NO. 7:

WATER-QUALITY SURVEY OF THE MERMENTAU RIVER BASIN, 1989-90

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Nutrients

Concentrations of nutrients in water samples collected from the study sites in the basin are presented in table 4. Based on nitrogen and especially phosphorus concentrations the lakes and streams represented by these sites can be categorized as eutrophic (Taylor and others, 1980). Lakes in the basin are typical of many shallow Louisiana lakes that are considered eutrophic because of their elevated nutrient levels (Louisiana Department of Environmental Quality, 1990b). The streams in the basin also are shallow and have elevated nutrient levels during much of the year. Concentrations of phosphorus in water collected at most of the 13 study sites exceeded the USEPA (1986) criterion for total phosphorus of 0.05 mg/L to control accelerated eutrophication in streams. Dissolved nitrate, the form of nitrogen most readily utilized for plant growth in streams, ranged from 0.07 to 0.22 mg/L at sites 1-5. This is a relatively large amount of nitrate to be found in flowing streams, especially as compared to sites 6-13, where dissolved nitrate concentrations ranged only from 0.04 to 0.02 mg/L. The concentrations at sites 1-5 could easily, in combination with the phosphorus concentrations found, produce highly eutrophic conditions resulting in algal blooms and subsequent taste, odor, and low dissolved oxygen problems. However, recognizing that concentrations of nitrate or nitrite that would exhibit toxic effects on warm or cold-blooded fish could rarely occur in nature, restrictive criteria are not recommended by the USEPA. The maximum contaminant level for total nitrate (as nitrogen) in domestic water supplies is 10 mg/L (U.S. Environmental Protection Agency, 1986).

Data in table 4 indicate that the water samples collected at site 2 on Bayou Plaquemine had high concentrations of total ammonia and total phosphorus (3.80 and 2.10 mg/L). The source of these nutrients probably was agricultural fertilizers, untreated sewage, or a combination of both. Fecal-coliform concentrations greater than 50,000 col/100 mL in the samples collected at site 2 indicate that Bayou Plaquemine could have been receiving untreated sewage. The relatively high alkalinity (table 3) and dissolved phosphorus concentration (table 4) in water samples collected at site 2 also indicated that the stream probably received runoff containing agricultural fertilizer.

Bayou des Cannes (sites 3, 4, and 7) and Nezpique (sites 5 and 8) contained water with smaller concentrations of ammonia and phosphorus than those in water from Bayou Plaquemine (sites 2 and 6) (table 4), but total phosphorus concentrations in water from these streams exceeded 0.15 mg/L, indicating the eutrophic nature of streams in the upper half of the basin. The elevated nitrogen and phosphorus concentrations in water in the upper part of the basin are also reflected in the elevated concentrations in water in the main stem of the Mermentau River (sites 9, 10, and 13). The lowest total phosphorus concentration in water in any of the tributaries of the Mermentau River (0.10 mg/L at site 12 in Bayou Lacassine) was well above the 0.05 mg/L USEPA criterion. The lowest total nitrogen concentration in water at any of the sites sampled was at Grand Lake (site 11). However, the total phosphorus concentration at this site (0.11 mg/L) was more than twice the 0.05 mg/L criterion.

A comparison of nitrogen and phosphorus concentrations in bottom material from sites 2 and 6 in Bayou Plaquemine illustrates how channel morphology and hydrology can affect nutrient concentrations. Bayou Plaquemine at site 2 is less than 2 ft deep, and generally has a downstream velocity of about 1 ft/s. The measured discharge at site 2 during sampling was 46.3 ft³/s. In contrast, the channel at site 6 was deeper (greater than 15 ft) and no velocity (or flow) was detected during sampling. Flow reversal due to tidal effects or pumping for irrigation also occurs at this site. Nitrogen and phosphorus concentrations in bottom material are much lower at site 2 than at site 6, which is opposite the trend in concentrations in water at these sites. The increases in nitrogen concentrations in bottom material at site 6 are mainly due to increased concentrations of the reduced forms of nitrogen such as ammonia. The oxidized forms of nitrogen (nitrite plus nitrate) decreased from site 2 to site 6 (10 and 0.04 mg/kg) (table 4). Apparently, stagnant water conditions and prolonged low DO concentrations at site 6 allow nutrients to accumulate in the bottom material without aerobic remineralization by bacteria. At site 2, the shallower depth and higher flow velocity promotes aerobic remineralization of nitrogen and phosphorus in bottom materials. The low nutrient concentrations in bottom material at Grand Lake (site 11) are probably due to the coarse, organic-poor, sandy substrate.

Trace Elements

Trace-element concentrations were determined for water and bottom-material samples. Trace-element concentrations in water (table 5) generally were near detection limits. Total arsenic concentrations of 5 and 8 µg/L at sites 1 and 2, are greater than the average values for the rest of the basin but are less than established criteria (table 2). Mercury concentrations of 0.2 µg/L in water at sites 9 and 11 (table 5) may indicate low-level mercury contamination, as increased mercury concentrations were also detected in the bottom material at site 9. However, the mercury concentration in water at site 10 was less than 0.1 µg/L and further investigation is needed to determine the extent of the possible mercury concentration at site 9.

Bottom-material samples were analyzed for concentrations of trace elements using techniques described by Horowitz and others (1989). Samples were also analyzed for the several physical and chemical factors that can affect the concentrations of trace elements (table 6). Grain size is one of the most commonly cited physical causes for variability in sediment trace-element concentrations (Jones and Bowser, 1978). Generally, as mean grain size decreases, trace-element concentrations increase (Forstner and Whitmann, 1981).

Various geochemical constituents, such as iron and manganese oxides and organic matter and physical characteristics of bottom material can affect trace-element concentrations (Forstner and Whitmann, 1981; Horowitz and Elrick, 1987). These physical and geochemical factors for bottom materials analyzed during this study were incorporated into a set of regression models and compared to a data base of 61 analyses of bottom-material samples collected from uncontaminated areas throughout the United States (Horowitz and others, 1990). Horowitz and others (1990) compared the measured concentrations in the Mermentau River basin to natural concentrations predicted by the models (table 7). Deviations from the predicted natural concentrations greater than 10 percent were considered indicative of anthropogenic contamination. For example, the concentration of arsenic in bottom material at site 2 was 21.5 mg/kg, which was substantially greater than concentrations at the other sampled sites. However, the predicted value of 19.3 mg/kg indicates that the physical and chemical characteristics of the bottom material were favorable for the accumulation of arsenic. Thus, the high concentration at site 2 does not necessarily indicate anthropogenic contamination. However, the concentration of arsenic at site 3 is significantly greater than the predicted value, and then may indicate contamination. A limitation of this comparison is that the Louisiana samples (table 6) were significantly different from the national samples, in that they had a smaller mean particle size and greater percent of organic matter.

The mercury concentration of 0.17 mg/kg in bottom material at site 9 was significantly greater than the predicted concentration of 0.12 mg/kg (table 7). A grain terminal was located at this site at one time, and it is possible that mercury, historically used as a fungicide, has accumulated at this site. The fact that mercury was detected in the water (0.2 µg/L) and bottom material (0.17 µg/g or 0.17 mg/kg) is evidence that mercury contamination at site 9 is probable.

Table 4. Nutrient concentrations in water and bottom material, September 19-21, 1989

[Constituents are reported as nitrogen and phosphorus; <, less than; concentrations in water are in milligrams per liter; concentrations in bottom material are in milligrams per kilogram]

Constituent	Concentration at indicated site												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Water													
Ammonia dissolved total	0.27	3.80	0.10	0.11	0.02	0.14	0.01	0.03	0.13	0.02	<0.01	<0.01	<0.01
Nitrite dissolved	.27	3.80	.11	.11	.02	.14	.01	.03	.13	.03	.01	<0.01	<0.01
Nitrate dissolved	.02	.11	.02	.02	.01	.01	<0.01	<0.01	.01	.01	.01	<0.01	<0.01
Organic nitrogen total	.07	.22	.17	.16	.09	.04	.03	.03	.03	.03	.03	.02	.03
Phosphorus dissolved total	1.43	2.70	.89	1.59	.88	.97	.90	.96	.87	.73	.65	.95	.88
Phosphorus dissolved total	.13	1.70	.06	.04	.11	.20	.12	.12	.22	.11	.08	.02	.02
Phosphorus dissolved total	.36	2.10	.18	.23	.23	.32	.21	.22	.30	.17	.11	.10	.13
Bottom material													
Ammonia	110	13	87	110	38	73	63	150	160	81	<10	61	406
Nitrate	10	10	130	10	10	.04	10	10	10	10	12	10	101
Ammonia + organic nitrogen	1,400	330	480	2,300	620	2,400	5,000	2,400	2,900	2,300	20	2,800	1,800
Phosphorus	430	84	110	450	210	600	590	520	550	590	41	360	710

Table 5. Trace elements in water and bottom material, September 19-21, 1989
[Concentrations in water (dissolved and total) are in micrograms per liter; concentrations in bottom material are in micrograms per gram; <, not collected; <, less than]

Element	1	2	3	4	5	6	7	8	9	10	11	12	13
Antimony dissolved total	—	—	—	—	—	—	—	—	—	—	—	—	—
Antimony bottom material	0.7	1.1	0.8	—	0.8	1.0	0.9	0.9	0.9	1.0	0.2	1.1	0.8
Arsenic dissolved total	4	6	2	1	2	3	3	2	3	2	1	1	1
Arsenic bottom material	5	8	4	4	3	3	4	3	4	3	2	2	2
Beryllium dissolved total	3	21.5	9.5	—	4.5	5.3	5.5	5	5	6	5	5.3	8.5
Beryllium bottom material	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium dissolved total	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium bottom material	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium dissolved total	1	1	1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium bottom material	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cobalt dissolved total	54	60	50	—	36	88	75	75	77	80	9	93	83
Cobalt bottom material	—	—	—	—	—	—	—	—	—	—	—	—	—
Copper dissolved total	8	3	2	2	12	3	2	2	1	3	2	2	2
Copper bottom material	—	—	—	—	—	—	—	—	—	—	—	—	—
Iron dissolved total	15	20	15	—	9	26	22	19	23	20	2	22	22
Iron bottom material	60	20	30	20	80	240	120	60	40	80	560	140	10
Lead dissolved total	—	—	—	—	—	—	—	—	—	—	—	—	—
Lead bottom material	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Manganese dissolved total	5	2	3	4	3	1	<1	1	<1	2	1	<1	<1
Manganese bottom material	22	48	31	—	24	34	33	33	34	32	3	46	52
Mercury dissolved total	42	48	880	510	230	120	120	350	220	30	78	58	29
Mercury bottom material	—	—	—	—	—	—	—	—	—	—	—	—	—
Nickel dissolved total	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel bottom material	3	3	2	1	2	3	1	<1	1	1	1	1	1
Selenium dissolved total	15	25	15	—	10	26	22	22	24	26	<1	27	34
Selenium bottom material	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium dissolved total	2	5	3	—	4	6	6	6	6	7	1	7	4
Vanadium bottom material	2	3	<1	2	2	2	1	<1	1	1	4	<1	50
Zinc dissolved total	20	20	10	30	20	—	10	10	10	10	10	10	10
Zinc bottom material	68	78	52	—	39	117	98	89	105	102	4	105	122

Table 6. Selected physical and chemical characteristics of bottom material, September 19-21, 1989
[TOC, total organic carbon; LOI, loss on ignition; OOM, other organic matter; <, less than; µm, micrometer; Mz, mean grain size; SA, surface area; m²/g, square meters per gram; µg/g, micrograms per gram; Mn, MnO₂, manganese removed by carbonate extraction method; Fe, FeO, iron removed by carbonate extraction method; Mn, MnO₂, manganese removed by manganese oxide extraction method]

Site no.	TOC (per cent weight)	LOI (per cent weight)	OOM (per cent weight)	Percent of sample less than indicated				Mz (µm)	SA (m ² /g)	Mn.CO ₂ (µg/g)	Fe.CO ₂ (µg/g)	Mn.MnO ₂ (µg/g)
				<125 µm	<63 µm	<16 µm	<2 µm					
1	1.18	4.5	3.32	96.1	83.3	30.3	7.0	26.9	21.08	190	425	45
2	.32	3.1	2.78	85.2	66.7	20.9	2.2	44.7	26.38	520	245	235
3	.56	3.2	2.64	83.3	71.7	20.1	1.7	45.2	22.85	425	680	120
5	.95	3.1	2.15	72.1	51.6	16.2	1.8	88.8	16.53	640	350	280
6	2.31	8.6	6.29	95.1	92.5	60.1	8.1	15.2	38.25	285	1,360	80
7	3.33	9.8	6.47	92.9	83.6	62.9	13.6	19.2	35.11	440	1,305	120
8	2.43	8.8	6.37	96.0	88.9	64.7	9.8	15.9	34.26	470	1,645	80
9	2.19	8.1	5.91	96.2	91.1	61.4	19.1	16.7	35.9	470	1,080	180
10	2.63	9.3	6.67	95.5	88.8	59.3	6.0	18.0	39.38	575	1,195	145
11	.12	.44	.32	45.1	2.0	.9	0.2	106.9	1.18	95	65	20
12	3.25	10.9	7.65	94.5	86.9	59.5	11.0	16.8	48.66	230	1,660	55
13	1.59	6.5	4.91	96.4	90.1	38.4	12.8	23.3	43.32	750	840	180